WORK PLAN

PRE-REMEDIAL ACTION SAMPLING

REVETMENTS 14, 19, 21, 22, 25 and 26

HAMILTON ARMY AIRFIELD

NOVATO, CALIFORNIA

DRAFT FINAL

Prepared by:

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ACRONYMS

ADR	Automated Data Review
ASTM	American Society of Testing and Materials
bgs	below ground surface
CCR	California Code of Federal Regulations
COC	Chain-of-Custody
COPCs	chemicals of potential concern
DQOs	Data Quality Objectives
EDD	Electronic Data Deliverable
EDMS	Electronic Data Management System
EDS	Environmental Design Section
EPA	Environmental Protection Agency
FSP	Field Sampling Plan

GPS	Global Positioning System
IDW	investigation derived waste
LCS	Laboratory Control Sample
MDL	Method Detection Limit
mg/kg	milligrams per kilogram
MS/MSD	matrix spike/matrix spike duplicate
PARCC	Precision, Accuracy, Representativeness, Completeness, Comparability
PM	Project Manager
PPE	Personal Protective Equipment
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QLs	Quantitation Limits
RI	Remedial Investigation
RPD	Relative Percent Difference
SSHP	Site Safety and Health Plan
STLC	Soluble Toxic Limit Concentration
TTLC	Total Toxic Limit Concentration
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
WET	Waste Extraction Test
WP	work plan

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NOVATO, CALIFORNIA

1.0 INTRODUCTION

This Work Plan (WP) presents the characterization sampling and analysis programs, sampling objectives, sampling strategy and rationale, sampling locations, sample collection methods, and sample handling procedures. The WP is designed to ensure that field procedures and documentation are standardized, so that data collected are valid and defensible. All field personnel will become familiar with the Field Sampling Plan (Chapter 3 of this WP) prior to conducting fieldwork. No groundwater will be collected as part of this sampling effort.

This WP includes a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). The FSP (Chapter 3) presents detailed field procedures to be followed in performance of this sampling effort, sampling strategy and rationale, sampling locations, sample collection methods, and sample handling procedures. The QAPP (Chapter 4) presents procedures to ensure data quality objectives are met, including field and laboratory procedures and details of the analytical protocols.

1.1 Project Objectives

The project objectives are to assess historic site activities to determine contaminants of potential concern (COPCs); determine if any of those COPCs are present at the site; if present, determine the vertical and horizontal extent of soil that has been adversely impacted by those COPCs.

1.2 Site History

HAAF is located in Novato, CA. HAAF is a former Air Force Base and Army Airfield. The location of HAAF is shown in Figure 1-1. The revetment pavements have been removed exposing the base course, sub base, and bay mud.

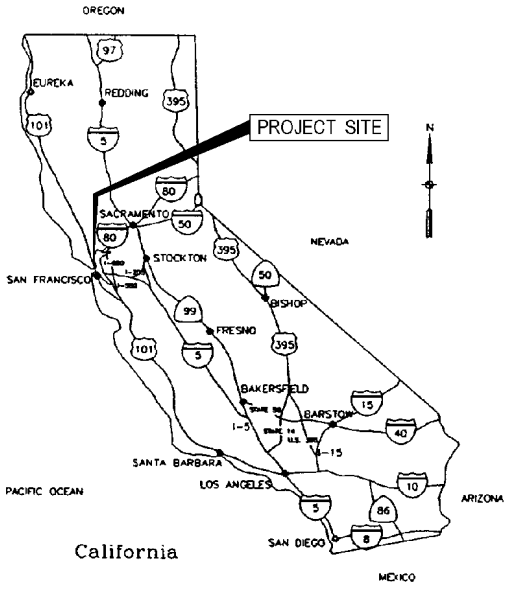

Figure 1-1: Project Location Map

1.3 Geology

The Hamilton Field site lies within the San Francisco-Marin structural block of the northern Coastal Range geomorphic province of California. The Coastal Range province is characterized by a series of nearly parallel mountain ranges and alluviated valleys that trend obliquely to the coastline in a northwesterly direction. The geologic units are composed of a heterogeneous mixture of intrusive, extrusive, metamorphic, and sedimentary rock types, which exhibit varying degrees of tectonic deformation.

The Hamilton Field site was reclaimed from low-lying tidal marshes adjacent to San Pablo Bay. Site grading produced fills consisting of up to 5 feet of gravelly sands, sands, and clays within the airstrip and the levee areas. In localized areas near the levees, and in areas along the deeper utility lines, fills of up to 10 feet in thickness can be found. Beneath the fill are natural, fine-grained, bay and marshland deposits commonly known as Bay Mud.

The Bay Mud typically consists of normally consolidated and lightly overconsolidated, highly plastic clays. Variable amounts of organic material (including interlayers of peat) and numerous small shell fragments are commonly incorporated into the Bay Mud. Stream and channel deposits, occurring as discontinuous lenses of silt and sand containing gravels locally, interfinger with the Bay Mud in areas near the hillsides along the western perimeter of the air field.

The Bay Mud is soft and plastic when wet but tends to shrink, harden, and become brittle when dried. Therefore, the Bay Mud in this area can locally be described as having an upper layer of

stiff, desiccated Bay Mud (0 to 5 feet in thickness) and a lower horizon of soft and saturated Bay Mud. These two layers are termed "Bay Mud Crust" and "Bay Mud." The Bay Mud thickness increases generally to the east across the site towards San Pablo Bay. The thickness of the Bay Mud is highly variable, ranging from a few feet near the northwest part of the property to more than 70 feet in the vicinity of the outboard levee.

Thick deposits of very stiff clays underlie the Bay Mud layer. Over most of the site there appears to be a relatively thin layer of very stiff to hard clay that may be of alluvial origin. Below this layer is an extensive deposit of Old Bay Clay (also known as Yerba Buena Mud) of variable thickness. The thickness of the Old Bay Clay increases from west to east towards San Pablo Bay.

The higher relief areas to the west and southwest of the Hamilton Field site are generally underlain by sandstone and shale bedrock from the Franciscan Complex of Jurassic to Cretaceous age. This unit apparently underlies the fill, the Bay Mud, and other geologically young sedimentary deposits beneath the site. A clayey weathering horizon typically develops on the bedrock foundation at the contact with the overlying deposits. Alluvial/Colluvial deposits, composed of sands and silts, are also present in some areas between the Bay Mud and the bedrock. These materials are thought to have been deposited in channels eroded into the bedrock. More recent alluvial deposits interfinger with the Bay Mud along the margins of the intertidal zone.

1.4 Regulatory Authority

The San Francisco Bay Area Regional Water Quality Control Board is the lead regulatory agency providing oversight.

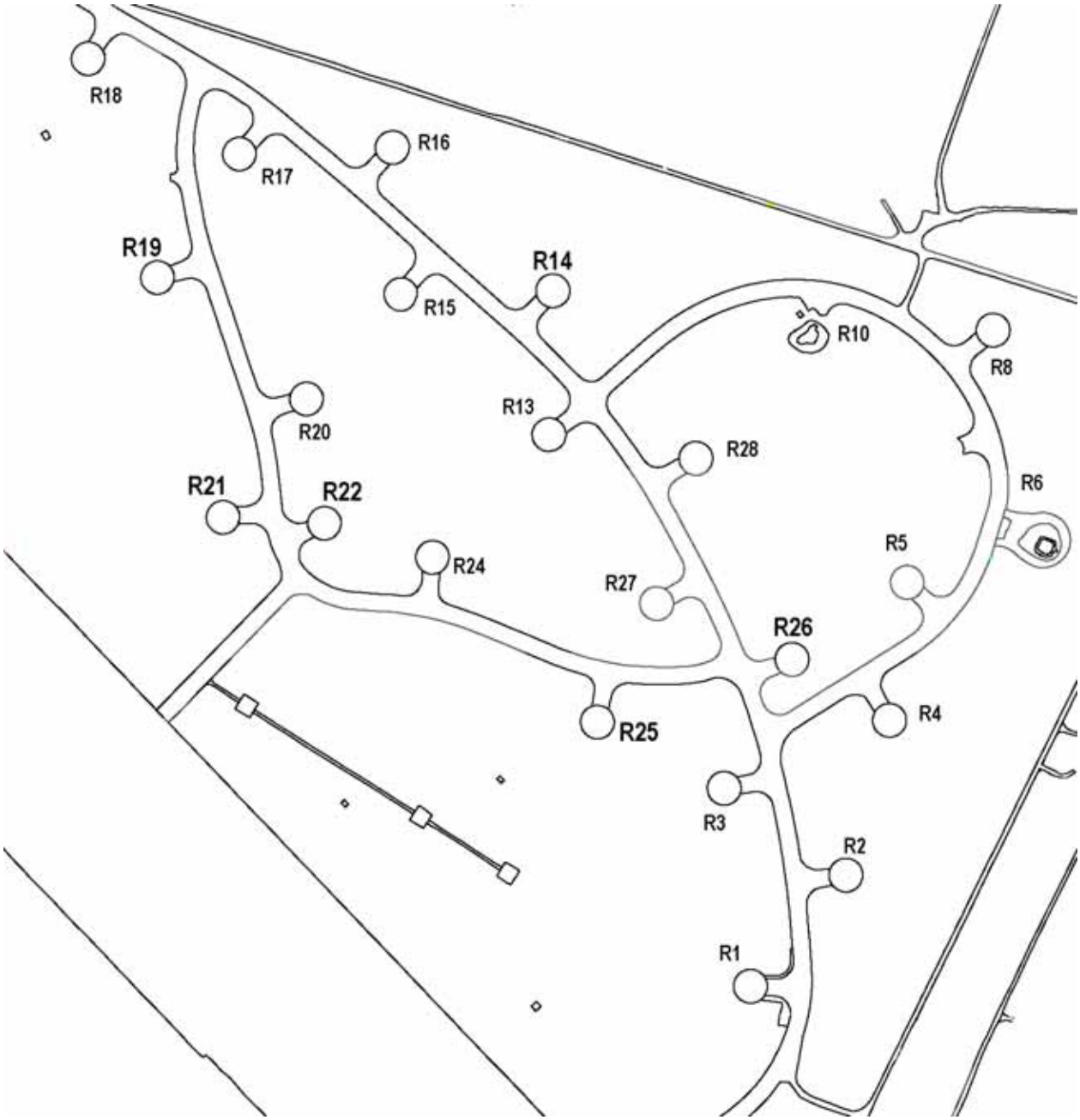

Figure 1-2:Revetments Map

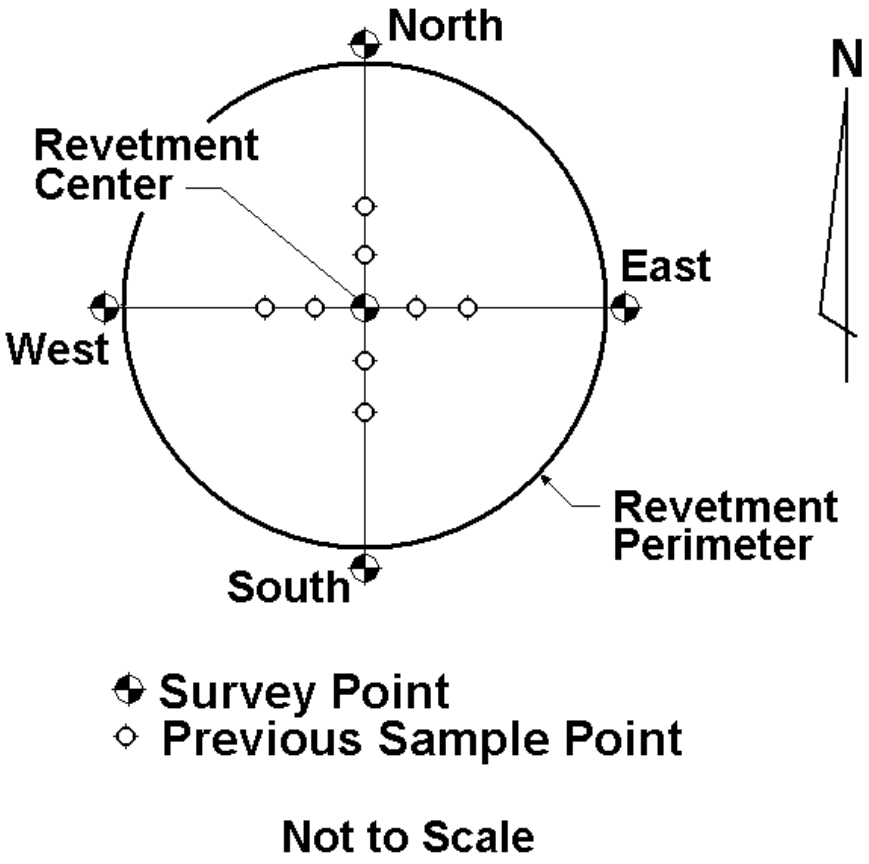

Figure 1-3: Revetment Previous Sample Locations

1.5 Project Staffing

The Environmental Design Section (EDS), Sacramento District, USACE under the supervision of Richard Meagher, Professional Engineer, California License Number 44858, prepared this WP, will perform the fieldwork and write the report. The following personnel are responsible for the preparation of this WP and will perform the site characterization.

USACE Team Members

Technical Team Leader	Pamela Amie
Environmental Engineer	Chuck Richmond, PE
Project Chemist	Pamela Amie
Project CIH	Dave Elskamp, CIH

2.0 DATA QUALITY OBJECTIVES

To generate data that will meet the project objectives, it is necessary to define the types of decisions that will be made, identify the intended use of the data, and design a data collection program. The Data Quality Objectives (DQOs) include any type of information utilized to form a sampling strategy or achieve the objective, not just analytical data. The DQO process will assist in determining the appropriate sampling design, detection and quantitation limits, analytical methods, and sample handling procedures. The DQO process was developed by the U.S. Environmental Protection Agency (EPA) from the document, *Guidance on the Data Quality Objectives Process* (EPA, 2000).

This site pre-remedial investigation effort is designed to assess any adverse impacts to the environment due to the activities at six revetment areas. The seven steps of the DQO process for the investigation of the six revetment areas are presented below.

Step 1: State the Problem

The Army is responsible for removing all contaminated soil resulting from DoD use of the revetments at Hamilton Army Airfield. Previous surface soil samples were collected from a borehole near a crack and/or from the perimeter of the concrete pad of each revetment. The previous data were compared to the action goals in the Record of Decision/Remedial Action Plan (ROD/RAP) *Main Airfield Parcel Record of Decision/Remedial Action Plan, Hamilton Army Airfield*, Final, August 2003. The previous sampling showed that of these six revetments, only Revetment 19 had any exceedences of the action goals around the perimeter of the concrete pad. The soil surrounding Revetment 19 has already been removed from the site by another project. Total Petroleum Hydrocarbons (TPHs) were found at concentrations exceeding the action goals at all six of the revetments. Metals (Barium, Boron, Copper, Manganese, and Vanadium) were detected sporadically at concentrations that marginally exceeded the action goals. For this reason, metals are not considered a driver for this investigation. This field effort will address data gaps that deal with the vertical and lateral extent of TPH in the purgeable and extractable ranges within the perimeter of the six former concrete pads.

Step 2: Identify the Decision

The decision is to determine the presence and extent of TPH soil contamination resulting from DoD activities that occurred at the six revetment areas.

Step 3: Identify the Inputs to the Decision

Given the documented activities at the revetments (i.e., aircraft staging) and the known concerns at similar revetments, the COPCs are TPH as gasoline (TPH-g), TPH as diesel (TPH-d) and TPH as motor oil (TPH-o) (IT, 1998). Comparison criteria for this investigation are in the ROD/RAP, Action Goals – Inboard Area.

Table 2-1: COPCs and Comparison Criteria

COPC	Action Goal Soil, mg/Kg dry weight (wt.)
TPH-g/JP-4	12
TPH-d/TPH-o	144

The analytical results will be compared to selected comparator values originating from the *Main Airfield Parcel Record of Decision/Remedial Action Plan, Hamilton Army Airfield*, Final, August 2003. In addition, the following information will be used to determine the most effective sampling strategy.

Table 2-2: Inputs to the Decision

Information Required	Location of Information	Activity to Provide Information
Historical information regarding the revetments	Comprehensive Remedial Investigation and Remedial Design Investigation	Previous Sampling Investigations
ROD/RAP Action Goals	ROD/RAP	None
Concentration of COPCs in soil within the perimeter of the former paved revetments	To be measured as part of this investigation	Collect soil samples from discrete intervals bgs from each of the six revetment areas and analyze for COPCs.

Step 4: Define the Boundaries

Spatial Boundaries: The revetment areas to be sampled have been physically identified based upon previous data. The revetment areas of the investigation are depicted on Figure 1-2. These boundaries are based upon historical information, visual notation, and basic knowledge of the revetment areas. The investigation area at each revetment may extend beyond that shown on Figure 1-3 based upon the results of the lab analysis.

Time Boundaries: The investigation will occur in fiscal year 2005. This may occur in more than one phase of sampling.

Step 5: Develop Decision Rule(s)

The following decision rules apply to all of the six revetment areas.

1) If any individual analytical results are equal to or greater that the action goal criteria from the ROD/RAP for COPCs, the area that the sample represents will be recommended for soil removal. Further sampling (vertically and/or horizontally) may be proposed and conducted to determine the total area to be excavated.

2) If all individual detections results are less than the action goal criteria, enough information will be available to determine if a removal action is required and, if so, the area to be excavated.

Step 6: Consequences of Decision Errors

The decision errors inherent in selecting sampling locations and analyzing chemicals consist of potential errors in sample design, location, heterogeneity, and sample analysis. Sample locations will be evenly distributed based on previous data from each revetment. Samples will be collected at each location from discrete depths bgs starting at surface and 12" below surface grade. The acceptable range of decision errors due to analytical errors will be evaluated during the data review, evaluation and validation process. Data found outside of acceptance criteria during validation will be qualified as estimated or rejected, as appropriate. The nature of the deficiency

and the proximity to the associated action level and other quality control measures, such as field duplicates, will be used to assess the usability of the data. Adherence to quality control protocols in Section 4.0 should reduce the probability of decision errors.

The sampling approach was selected using a combination of systematic and stratified sampling strategies and is based upon the information gathered from discussions with the client and regulators, and information obtained during a site visit.

Null Hypothesis: The COPCs concentrations in the soil are greater than the action goal criteria.

False Rejection Error and Consequences: The data incorrectly indicate that the COPCs concentrations are below either the comparison criteria (false negative result or low bias). No further action would be taken, resulting in a potential for unacceptable risk to the environment. The tolerance for the false rejection error is extremely low, so any potential for false negatives or low bias would be scrutinized during data validation and reanalysis may be required.

False Acceptance Error and Consequences: The data incorrectly indicate that the COPCs concentrations are greater than the comparison criteria (false positive or high bias). The soil would be recommended for removal and the costs of remediating the site would be higher than necessary.

Step 7: Optimize the Sampling Design

The sampling design for the pre-remedial investigation of the revetments is listed below along with the applicable parameters. Figure 1-3 illustrates the locations of previous sample locations. Proposed sample locations will be based on the locations of the previous sample locations. Anticipated accuracy and precision parameters and compound-specific quantitation limits (QLs) are listed in Appendix C and Table 4-3, respectively.

Table 2-3: Sampling Design

Investigation Location	Sampling Design	Estimated Number of Samples	Analytical Method(s), Analytes	Rationale
Revetments 14, 19, 21, 22, 25, and 26	Sample locations will be placed at the previous sample location of each revetment and at 10' out from the previous sample location in four directions (north, south, west and east). Soil samples will be collected from the surface and 12": below ground surface (bgs) at each sample location. Additional samples may be collected based upon initial soil COPCs concentrations relative to comparison criteria. Lateral step-outs shall be 5' and vertical step-downs shall be 6".	36 – 54 samples	EPA Method SW-846 8015B for TPH-G, TPH-D, and TPH-O. At revetments 14 and 25, samples will not be collected for TPH-G.	The sampling will start at the location of previously known contamination. The sampling will step out and down from that point as necessary to define the boundaries of the contaminated soils. Due to the use of these revetments, the concrete pads, and the tight soils beneath them, it is presumed that the contamination did not travel far from the source.

2.1 Regulatory Authority

The San Francisco Bay Area Regional Water Quality Control Board is the lead regulatory agency providing oversight.

3.0 FIELD SAMPLING PLAN

3.1 Sampling Procedures

The field methods to be employed during this sampling event are detailed below. All fieldwork performed will be conducted in accordance with this WP written specifically for this event. All fieldwork will be performed in accordance with the National Environmental Policy Act (NEPA).

The site-specific field activities will include surface and near-surface soil sampling from selected locations for off-site chemical analysis. All of the initial sample reference points will be located by survey. The reference grid is North American Datum 1983, Zone 6.

3.1.1 Sampling Plan

Samples will be collected from numerous surface and near surface locations for sample analysis to characterize the potential soil contamination in four directions from the previous location at each of the following locations: Revetments 14, 19, 21, 22, 25 and 26. A systematic sampling strategy will be implemented at each revetment area. Samples will be collected from selected areas where contamination is obvious due to preferential pathways created from the previous cracks in the concrete revetment pavement. Accurate survey reference points for each of each sample location will be established and staked.

The rationale and analytical criteria for the collection of step-out and step down sample locations is described in Step 7 of the DQOs (Section 2.0).

Samples will be collected at each location from discrete depths (0", 12", and if needed, 18") bgs. Samples will be collected using a stainless steel hand auger. Samples will placed into a stainlees steel sleeve or a glass jar. Encore samples will be collected from the soil in the hand auger. The soil from each the hand auger shall be field classified in accordance with American Society of Testing and Materials (ASTM) D-2488-93, *Description and Identification of Soils (Visual Manual Method)* (ASTM, 1993). The ASTM system is a further refinement of the soil classification of the Uniform Soil Classification System (USCS) (USBR &USACE, 1952).

Initial samples will be obtained from surface and 12" depth using a slide hammer and hand augers. Hand augers may be driven using appropriately sized electric drills powered by remote generator. One drill will be a rotohammer type with a masonry auger. A second drill will be a rotohammer type with a sampling auger.

Table 3-1: Summary of Soil Samples for Analysis of Metals

Sample Locations	Depth of samples, bgs	Minimum Number of Soil Samples	Field Duplicates (5% of Primary Samples)	QA Samples (5% of Primary Samples)
Revetments 14, 19, 21, 22, 25 and 26	0 to 2-feet	36	2	2

3.1.2 Analytical Plan

Soil samples will be collected from the revetment areas. The COPCs include TPH-g, TPH-d, TPH-o. An off-site laboratory will analyze the discrete soil samples using EPA SW-846 methods. Additional samples may be collected based upon preliminary analysis results and/or professional judgment of the on-site environmental engineer/geologist.

3.2 Quality Control Samples

The following quality control (QC) samples will be collected to assess precision and accuracy.

3.2.1 Field Duplicates (QC)

Duplicate field samples provide information regarding precision for the entire measurement system including sample acquisition, homogeneity, handling, shipping, storage, preparation, and analysis. Five percent of the field samples will be submitted as duplicates.

3.2.2 Quality Assurance (QA) Samples

QA split samples serve an oversight function in assessing the analytical portion of the measurement samples. Five percent of field samples will be submitted as QA samples.

3.3 Sampling Equipment and Procedures

3.3.1 General Information

The fieldwork for this investigation is anticipated to begin in Spring 2005. All fieldwork will be performed in accordance with the Work Plan and the Site Safety and Health Plan (SSHP). Underground Service Alert (USA) will be requested to locate all underground utilities prior to the start of work. Records of the fieldwork, including samples collected, will be kept in a bound notebook unique to this study. Photographs will be taken of each portion of the site before and during sampling activities to document site conditions.

A survey of each revetment will be made to locate survey reference locations as shown in Figure 1-3. The coordinates for each location will be used for accurate mapping of the areas exceeding the action goals.

3.3.2 Sampling Procedures

This section describes the general sampling procedures to be used on this project. All soil sampling equipment will be dedicated equipment (used once and disposed).

After collection, each soil sample will be labeled as described in Section 3.6.1. All sample tube sections to be sent to the laboratory will have a Teflon sheet placed on each end and then an end cap placed over the end of the tube. EnCore samplers will be placed in one of the EnCore sampler bags and sealed for shipment. All samples will be placed in coolers and sent to the laboratory via Federal Express.

3.4 Borehole Abandonment

Soil not used as part of a sample shall be backfilled into the sample hole it came from.

3.5 Sample Containers and Preservation

A complete set of labels will be prepared for each anticipated sample in advance of the sampling event. All sample tubes and EnCore sample bags will be labeled with the date, sample number, project name, sampler's initials, and parameters for analysis.

3.6 Sample Documentation and Handling

3.6.1 Sample Numbering and Labels System

A unique identification number will be assigned to each sample. Each sample will be numbered and include the following information:

- Project name (HAAF-R);
- Specific revetment number and direction (E, W, S, N, O (center of revetment)) denotation;
- Sample number (e.g., 1800, 1801, etc.); and
- Specific distance from the center location will be denoted as letters A, B, C and
- Depth, in feet;

An example: Revetment 14, east direction, 10' from the center of the revetment, sample location 1800, sample depth 0 to ½-feet, the sample number would be HAAF-R14E-A-1800-0.5.

All information pertaining to a particular sample is referenced by its identification number. It is recorded on the sample container, in the field logbook, and on the sample chain-of-custody form.

Each sample collected at the site will be labeled with the following information:

- Project Name

- Sample identification number;
- Sample location;
- Date and time of collection;
- Name of person(s) collecting the sample;
- Analysis requested;
- Preservation; and
- Any other information pertinent to the sample.

3.6.2 Sample Packaging and Shipping

Samples will be transported as soon as possible after sample collection and preparation to the off-site laboratory for analysis. The following procedures are to be used when packing and transporting samples to the off-site laboratory:

- Use metal or equivalent strength plastic coolers or sturdy shipping containers,
- Package samples in individual plastic bags and place in container;
- Put paperwork (chain-of-custody record, etc.) in a waterproof plastic bag and tape it to the inside of the container,
- Tape the container lid and any drain shut with fiber-reinforced tape,
- Place at least two numbered and signed custody seals on container, one at the front right and one at the back left of cooler,
- Attach completed shipping label to the top of container and ship following the carrier's instructions.

Sample containers will be shipped via Federal Express for overnight delivery to the laboratory. A copy of the bill of lading (air bill) is to be retained and becomes part of the sample custody documentation. The laboratory will be notified in advance of all shipments by telephone on the day of shipment and by advanced scheduling.

3.6.3 Chain-of-Custody Procedures

All samples will be accompanied to the laboratory by a chain-of-custody form (COC), i.e., CESPK Form 111. The COC contains the following information:

- Project name;
- Sample numbers;
- Sample collection point;
- Sampling date;
- Time of collection of samples;
- Sample matrix description;
- Analyses requested for each sample;
- Preservation method;
- Number and type of containers used;
- Any special handling or analysis requirements.
- Signature of person collecting the samples;
- Signature of persons involved in the chain of possession.

The COCs will be filled out with ink. All information on the COCs shall match the information found on the label. When the samples are transferred from one party to another, the individuals will sign, date, and note the time on the form. A separate form will accompany each delivery of

samples to the laboratory. The COC will be included in the container used for transport to the laboratory. The sampling personnel will retain a copy of the form.

3.7 Investigation Derived Waste

It is anticipated that investigation derived waste (IDW) personal protective equipment (PPE), and used clear acetate sample tubes will be generated during the course of the fieldwork. All PPE and used tubes will be properly disposed. All other wastes will be disposed of in a trash receptacle.

4.0 QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) presents functions, procedures, and specific quality assurance (QA) and quality control (QC) activities to ensure that all analytical data are consistently produced and of known quality in order to achieve the data quality objectives defined in Section 2.0. The QAPP provides data specifications for all anticipated analyses and COPCs and Comparison Criteria

The QAPP format was derived following EPA QA/G-5, *Guidance for the Preparation of Quality Assurance Project Plans* (EPA, 2002) and the QAPP elements were developed following EPA QA/R-5, *Requirements for Quality Assurance Project Plans* (EPA, 2001).

The purpose of this QAPP is to ensure that the data collected are of known and documented quality and useful for the purposes for which they are intended. The procedures described are designed to obtain data quality indicators for each field procedure and analytical method. Data quality indicators include the PARCC parameters (Precision, Accuracy, Representativeness, Comparability, and Completeness). To ensure that quality data continues to be produced, systematic checks must show that test results and field procedures remain reproducible and that the analytical methodology is actually measuring the quantity of analytes in each sample.

The reliability and credibility of analytical laboratory results can be corroborated by the inclusion of a program of scheduled replicate analyses, analyses of standard or spiked samples, and analysis of split samples with QA laboratories for some projects. Regularly scheduled analyses of known duplicates, standards, and spiked samples are a routine aspect of data reduction, validation, and reporting procedures.

4.1 Analytical Methods Requirements

Table 4-1 provides a summary of the required analytical methods, parameters, and associated holding times required for this project.

Table 4-1: Summary of Analytical Methods

Analytical Method	Parameters	Holding Time
SW8015B/5035B	TPH-G	Freeze within 48 hours of sample collection; 14 days to analysis
SW8015B/3550B/3630C	TPH-D, TPH-O	14 days for extraction; 40 days to analysis

4.1.1 Sample Preparation Methods

Sample preparation methods are described in detail within the applicable method. Appendix B provides a brief summary of the sample preparation methods.

4.1.2 Analytical Methods

The soil samples will be analyzed using EPA SW-846 Method 8015B. To confirm analytical data obtained by the methods, selected soil samples will be analyzed for all of the constituents by the primary and QA laboratories. The methodologies for these analyses are provided in Appendix B and the analytical instrumentation calibration is provided in Appendix C.

4.2 Analytical Data Reduction and Review

The selected laboratory will be responsible for providing complete documentation of all analytical test results and QA/QC sample results in a comprehensive certificate of analysis.

4.3 Quality Assurance And Quality Control Procedures

Different types of replicate and blank samples are collected as part of the QA/QC program. Several QC samples will be analyzed for this project to provide a means to assess both field and analytical performance. The following sections describe the different types of QC samples and how they are assessed to evaluate data quality.

4.3.1 Field QA/QC Checks

Field QC samples are discussed in Section 3.2 and consist of field duplicates, and QA samples. Each type of field QC sample undergoes the same preservation, analysis, and reporting procedures as the related environmental samples.

The following table summarizes the field QC sample collection frequencies and acceptance limits.

Table 4-2: Field QC Sample Collection Frequencies And Acceptance Limits

QC Sample Type	Minimum Collection Frequency	Acceptance Limits
Field Duplicate	1 per 20 investigative samples	RPD ≤ 50 RPD
Confirmation Samples	Approximately 1 per 10 investigative samples	Correlation coefficient >0.9
QA Samples	1 per 20 investigative samples	Ratio of results to QA results is 0.40 to 2.5

4.3.2 Analytical QA/QC Checks

The laboratory will have a QA/QC program that monitors data quality with internal QC checks. Those specific internal QC checks and frequency of checks are provided in Appendix C and in the method-specific laboratory QA/QC procedures. These laboratory QC checks include blank samples, control samples, duplicate analyses, and matrix spikes / matrix spike duplicates.

4.4 Data Quality Indicators (PARCC Parameters)

The PARCC parameters are qualitative and quantitative statements regarding the quality characteristics of the data used to support project objectives and ultimately, environmental decisions. These parameters are presented in the remainder of this section.

4.4.1 Precision

Precision is a measure of the degree to which two or more measurements are in agreement, and describes the reproducibility of measurements of the same parameter for samples analyzed under similar conditions. A fundamental tenet of using precision measurements for QC is that precision will be bounded by known limits. Results outside these predetermined limits trigger corrective actions. Precision will be evaluated from field duplicate data, laboratory duplicate data, and MS/MSD data. Acceptable precision is achieved when RPD values are within the acceptance criterion.

4.4.1.1 Field Precision

Field precision objectives are met by collecting and measuring field duplicates at a rate of 1 duplicate per 20 environmental samples. The acceptance limit for field duplicate precision is ≤ 50 RPD for all methods. This precision estimate encompasses the combined uncertainly associated with sample collection, homogenization, splitting, handling, laboratory and field storage (if applicable), sub-sampling and preparation for analysis, and analysis.

4.4.1.2 Laboratory Precision Objectives

Laboratory precision QC samples (i.e., MS/MSD) will be analyzed with a minimum frequency of five percent. Acceptance limits for laboratory precision is ≤ 35 RPD.

4.4.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. This parameter is assessed by measuring spiked samples or well-characterized samples of certified analyte concentrations (e.g., LCS). Accuracy measurements are designed to detect biases resulting from the sample handling and analysis processes.

4.4.2.1 Field Accuracy Objectives

Field accuracy is maintained by monitoring adherence to procedures that prevent sample contamination or degradation. Accuracy also shall be improved qualitatively through adherence to all sample handling, preservation, and holding-time requirements.

4.4.2.2 Analytical Accuracy Objectives

Analytical accuracy is measured through the comparison of a spiked sample or LCS result to a known or calculated value and is expressed as a percent recovery (%R). MS/MSD analyses measure the combined accuracy effects of the sample matrix, sample preparation, and sample measurement. LCSs are used to assess the accuracy of laboratory operations with minimal sample matrix effects. Post-digestion spikes are used to assess the accuracy of the analytical measurement on the sample extract or digestate. Each spiked sample shall be spiked with representative target analytes for the analysis being performed to ensure that accuracy measures are obtained for each target analyte. Spiking concentrations shall equal or approximate the mid-level calibration standard. Laboratory accuracy is assessed via comparison of calculated percent recovery values to accuracy control limits.

4.4.3 Representativeness

Representativeness is an expression of the degree to which the data accurately and precisely represents a characteristic of a population or environmental condition existing at the site. Adherence to this work plan and use of standardized sampling, handling, preparation, analysis, and reporting procedures ensure that the final data accurately represent the desired populations. Representativeness will be evaluated during data assessment to evaluate whether each datum belongs to the observed data distribution through outlier testing. Any anomalies will be investigated to assess their impact on statistical computations as part of the report.

4.4.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected under normal conditions. Completeness is expressed as a percentage. Technical completeness is a measure of the amount of usable, valid laboratory measurements per matrix obtained for each target analyte. Usable, valid results are those that are judged, after data assessment, to represent the sampling populations and to have not been rejected for use through data validation or data assessment. Analytical completeness objectives are 90 percent for each critical target analyte. The analytical completeness objective is 100 percent for sample holding times. Qualifications on the use of data caused by incomplete data sets will be documented in the report.

4.4.5 Comparability

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measurement), and by ensuring that reporting and detection limits are sufficiently low to satisfy project detection and quantitation criteria for the duration of the project. The QLs anticipated for this project are presented in Table 4-3.

Table 4-3: Target Analytes, Quantitation Limits and Comparison Criteria

Analyte	Detection Limits[1] Soil, mg/kg Dry Weight	Quantitation Limits Soil, mg/kg Dry Weight	Action Goals[2] Soil, mg/kg Dry Weight
TPH-G	0.01	1	12
TPH-D/O	0.784	100	144

[1] Report the test result to MDL and "J" flag the result below the QL. These detection limits were calculated using a clean matrix and may not be achievable with the samples collected for this project. By reporting down to the detection limit, there is an increased probability of low-level false positives.

[2] Action Goals – Inboard Sites, ROD/RAP

Notes: Both MDLs and QLs for soil in the tables are undiluted. Actual reported concentrations will be adjusted for dry weight and any dilution.

mg/kg = milligrams per kilogram

4.5 Preliminary Data Deliverables and Final Data Packages

All preliminary data shall be reported within 24 hours after sample receipt at the laboratory. The data shall be submitted in a facsimile transmittal to the BRAC Army office to the attention of the field chemist. All data shall be reported at the method detection limit (MDL) value where detects between the MDL and QL are qualified as estimated values.

At the conclusion of all analytical work for this project, the laboratory will report all analytical data in the form of comprehensive certificates of analysis. The final certificates of analysis will be submitted back to USACE no later than 21 days after delivery of each field sample to the laboratory.

4.6 Data Validation Reports

The project team will review all the data generated for the project. Data qualifiers will be assigned for the following QC outliers: contaminated blanks, LCS outliers, and MS/MSD outliers. Additionally, approximately 10 percent of the data will be validated at the raw data level to verify analyte detection and quantitation.

5.0 REFERENCES

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APPENDIX A

Calibration and Internal Quality Control Procedures

ACRONYMS AND ABBREVIATIONS

CCC	Calibration check compound
CCV	Continuing calibration verification standard
COD	Coefficient of determination
CV	Calibration verification standard
%D	Percent difference
GC	Gas chromatography
GC/MS	Gas chromatography/mass spectrometry
ICS	Interference check standard
ICV	Initial calibration verification standard
MDL	Method detection limit
MS/MSD	Matrix spike/matrix spike duplicate
LCS	Laboratory control sample
QC	Quality control
QL	Quantitation limit
r	Correlation coefficient
r^2	Coefficient of determination
RF	Response factor
RPD	Relative percent difference
RRF	Relative response factor
RSD	Relative standard deviation
SIM	Selective Ion Monitoring
SPCC	System performance check compound
USACE	United States Army Corps of Engineers

Summary of Calibration and Internal Quality Control Procedures for Method SW8015B (TPH)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8015B	Total Petroleum Hydrocarbons as gasoline, diesel and motor oil	Five-point calibration	Biannually or when daily calibration verification fails	RSD for average RF <20%	1) Identify and repeat analysis for outlying points 2) Recalculate using valid points
		CCV	Daily: before sample analysis, every 10 samples, and at the end of the analytical sequence	Response for all analytes within ±15% of expected value for primary and secondary column	1) Reanalyze CCV 2) If still out, identify and correct problem 3) Recalibrate and reanalyze all samples since last valid CCV

Summary of Calibration and Internal Quality Control Procedures for Method SW8015B (TPH)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
		Method Blank	1 per preparation batch	All analytes < ½ QL	1) Investigate possible contamination source 2) Take appropriate corrective action 3) Repeat instrument blank analysis 4) Reextract and reanalyze all samples processed with a contaminated blank at no cost to USACE, unless analyte is not detected in associated samples or present at greater than 10x blank concentration. 5) Flag sample results associated with blank contamination
		LCS	1 LCS per preparation batch	Comparison recovery limits for gas range is 65-135%; for diesel/oil range is 50-150%	1) Reanalyze LCS. 2) If still out identify and correct problem. 3) Reextract and reanalyze affected samples.

Summary of Calibration and Internal Quality Control Procedures for Method SW8015B (TPH)

Analytical Method	Applicable Parameter	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW8015B	Total Petroleum Hydrocarbons	MS and MSD (level of spike must be less than the mid-level standard of the calibration curve)	1 MS/MSD per preparation batch	Comparison recovery limits 65-135% for gas range and 50-150% for diesel/oil range RPD <35% for soil samples RPD >20 % for water samples	1) Evaluate for supportable matrix effect. 2) If no interference is evident re-extract and reanalyze MS/MSD once. 3) If still out report both sets of data.
		Surrogate spikes	Every sample, spike, standard, and method blank	Comparison recovery limits 65-135% for gas range and 50-150% for diesel/oil range	1) Recalculate result; if still out: 2) Evaluate for supportable matrix effect. 3) If no interference is evident reanalyze affected sample(s) and narrate any outliers.
		QL	Low point on initial calibration curve.	QLs established shall not exceed those required by project; Refer to Table 4-3.	QLs that exceed established criteria shall be submitted to USACE for approval prior to any project samples analyses

All corrective actions associated with USACE project work shall be documented and the records maintained by the laboratory.

Test Methods for Evaluating Solid Waste, SW-846, USEPA, December 1998.

CCV	= Continuing Calibration Verification	ICV	= Initial Calibration Verification	DL	= Detection Limit
QL	= Quantitation Limit	GC	= Gas Chromatograph	LCS	= Laboratory Control Sample
RF	= Response Factor	MDL	= Method Detection Limit	RPD	= Relative Percent Difference
MS	= Matrix Spike	RSD	= Relative Standard Deviation	RT	= Retention time
MSD	= Matrix Spike Duplicate	TPH	= Total Petroleum Hydrocarbons		

APPENDIX B

Data Qualifier Conventions for Analyses

Table B-1

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects		Non-detects	
		Non Biased	Biased		
HOLDING TIMES	1) Holding time exceeded by 2 times or less 2) Holding time exceeded by greater than 2 times	J	J- J-	UJ R	Sample
INITIAL CALIBRATION	1) $r < 0.995$	J	J	UJ	All samples in same instrument batch

Table B-1

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects		Non-detects	
		Non Biased	Biased		
INITIAL CALIBRATION VERIFICATION (ICV)	1) % Recovery > 110% but ≤ 125% (Hg, % Recovery > 120% but ≤ 135%)	J	J+	No qual.	All samples bracketed by ICV
	2) % Recovery > 125% (Hg, % Recovery > 135%)	R	R	No qual.	
	3) % Recovery < 90% but ≥75% (Hg, % Recovery < 80% but ≥ 65%)	J			
	4) % Recovery < 75% (Hg, % Recovery < 65%)	J	J-	UJ	
			J-	R	

Table B-1

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects		Non-detects	
		Non Biased	Biased		
CONTINUING CALIBRATION VERIFICATION (CCV)	1) % Recovery > 110% but ≤ 125% (Hg, % Recovery > 120% but ≤ 135%)	J	J+	No qual.	All samples bracketed by CCV
	2) % Recovery > 125% (Hg, % Recovery > 135%)	R	R	No qual.	
	3) % Recovery < 90% but ≥ 75% (Hg, % Recovery < 80% but ≥ 65%)	J	J-	UJ	
	4) % Recovery < 75% (Hg, % Recovery < 65%)	J	J-	R	
METHOD BLANK CONTAMINATION	Sample results less than or equal to 5 times the blank contamination	U	U	No qual.	All samples in the same Analytical (Preparation) Batch

Table B-1

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects		Non-detects	
		Non Biased	Biased		
MATRIX SPIKE RECOVERY	1) % Recovery < CL but ≥ 30%	J	J-	UJ	All samples from same site and similar matrix interference
	2) % Recovery <30%	J	J-	R	
	3) % Recovery > CL	J	J+	No qual.	
	4) RPD > CL	J	J+	UJ	
LABORATORY CONTROL SAMPLE RECOVERY	1) % Recovery < CL but ≥ 50%	J	J-	UJ	All samples in the same Analytical (Preparation) Batch
	2) % Recovery <50%	J	J	R	
	3) % Recovery > CL	J	J+	No qual.	
	4) RPD > CL	J	J	UJ	

Table B-1

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects		Non-detects	
		Non Biased	Biased		
REPORTING LIMITS	Reporting limits not matching the project specified limits	No qual.	No qual.	No qual.	Sample (noted in outlier report)
	Reported result less than the project reporting detection limit.	J	J	No qual.	Sample
FIELD DUPLICATES	RPD > CL	No qual.	No qual.	No qual.	Non-compliant results
FIELD BLANKS **EQUIPMENT BLANKS**	Sample results within 5 times blank contamination	U	U	No qual.	All samples in the same sampling event

Alternate qualifiers are acceptable on a case-by-case basis based upon validator's professional judgment. All deviations from the above qualification scheme shall be documented.

Table B-2

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
HOLDING TIMES	1) Holding time exceeded by 2 times or less		J-	UJ	Sample
(Extraction/Analysis)	2) Holding time exceeded by greater than 2 times	J	J-	R	
COOLER TEMPERATURE	1) > 6 and ≤10 degrees Centigrade	J	J-	UJ	All samples shipped in the affected cooler. (Shipping Batch)
	2) >10 degrees Centigrade	J	J-	R	
	3) < 2 degrees Centigrade	No qual.	No qual.	No qual.	
INITIAL CALIBRATION	1) %RSD > 20%	J	J	UJ	All samples in the same instrument batch
	2) r < 0.995	J	J	UJ	

Table B-2

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
INITIAL CALIBRATION VERIFICATION (ICV)	1) % Difference > +25%	J	J+	No qual.	All samples bracketed by the ICV
	2) % Difference < -25% and ≥ -50%	J	J-	UJ	
	3) % Difference < -50%	J	J-	R	
CONTINUING CALIBRATION (CCV)	1) % Difference > +15%	J	J+	No qual.	All samples bracketed by the CCV
	2) % Difference < -15% and ≥ -50%	J	J-	UJ	
	3)% Difference < -50%	J	J-	R	

Table B-2

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
METHOD BLANK CONTAMINATION	1) Common lab contaminant results less than or equal to 10 times the blank contamination	U	U	No qual.	All samples in the same Analytical (Preparation) Batch
	2) Other compound results less than or equal to 5 times the blank contamination	U	U	No qual.	
SURROGATE RECOVERY	1) % Recovery < CL but ≥ 10%	J	J-	UJ	Sample
	2) % Recovery <10%	J	J-	R	
	3) % Recovery > CL	J	J+	No qual.	

Table B-2

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
MATRIX SPIKE RECOVERY	1) % Recovery < CL but ≥ 10%	J	J-	UJ	Parent Sample
	2) % Recovery <10%	J	J-	R	
	3) % Recovery > CL	J	J+	No qual.	
	4) RPD > CL	J	J	UJ	
LABORATORY CONTROL SAMPLE RECOVERY	1) % Recovery < CL but ≥ 10%	J	J-	UJ	All samples in the same Analytical (Preparation) Batch
	2) % Recovery <10%	J	J-	R	
	3) % Recovery > CL	J	J+	No qual.	
	4) RPD > CL	J	J	UJ	

Table B-2

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
REPORTING LIMITS	Reporting limits not matching the project specified limits.	No qual.	No qual.	No qual.	Sample (noted in outlier report)
	Results reported below the project reporting detection limit.	J	J	No qual.	Sample
FIELD DUPLICATES	1) RPD > CL	No qual.	No qual.	no qual.	Non-compliant results
FIELD BLANKS EQUIPMENT BLANKS	1) Common lab contaminant results within 10 times blank contamination	U	U	No qual.	All samples in the same sampling event
	2) Other lab contaminant results within 5 times blank contamination	U	U	No qual.	

Table B-2

Data Qualifier Convention for GC Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
TRIP BLANKS	1) Common lab contaminant results within 10 times blank contamination	U	U	No qual.	All samples in the same Shipping Batch
	2) Other lab contaminant results within 5 times blank contamination	U	U	No qual.	

Alternate qualifiers are acceptable on a case-by-case basis based upon validator professional judgment. All deviations from the above qualification scheme shall be documented.

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
HOLDING TIMES (Extraction/Analysis)	1) Holding time exceeded by 2 times or less 2) Holding time exceeded by greater than 2 times	J J	J- J-	UJ R	Sample
COOLER TEMPERATURE	1) > 6 and ≤10 degrees Centigrade 2) >10 degrees Centigrade 3) < 2 degrees Centigrade	J J No qual.	J- J- No qual.	UJ R No qual.	All samples shipped in the affected cooler (Shipping Batch)

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
INSTRUMENT TUNING	1) Ion abundance criteria not met	JN	JN	R	All samples associated to an initial calibration, if tune is associated to an initial calibration. All samples in same instrument batch, if tune is associated with a calibration verification.
INITIAL CALIBRATION	1) Average RRF < 0.05	J	J	R	All samples associated with the initial calibration
	2) %RSD > 30%	J	J	UJ	
	3) r < 0.995	J	J	UJ	

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
INITIAL CALIBRATION VERIFICATION (ICV)	1) Average RRF < 0.05	J	J	R	All samples associated to the ICV
	2) % Difference > +25%	J	J+	no qual.	
	3) % Difference < -25% and ≥ -50%				
	4) % Difference < -50%	J	J-	UJ	
		J	J-	R	

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
CONTINUING CALIBRATION VERIFICATION (CCV)	1) Average RRF < 0.05	J	J	R	All samples in the instrument batch
	2) % Difference > +25%	J	J+	no qual.	
	3) % Difference < -25% and ≥ -50%				
	4) % Difference < -50%	J	J-	UJ	
		J	J-	R	

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
METHOD BLANK CONTAMINATION	1) Common lab contaminant and tentatively identified compound (TIC) results less than or equal to 10 times blank contamination	U	U	No qual.	All samples in the same analytical batch (preparation batch)
	2) Other compound results less than or equal to 5 times blank contamination	U	U	No qual.	

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
SURROGATE RECOVERY	1) % Recovery < CL but ≥ 10%	J	J-	UJ	Sample
	2) % Recovery <10%	J	J-	R	
	3) % Recovery > CL	J	J+	no qual.	
	Note: For semivolatile analysis, two or more surrogates in a fraction must be out of criteria for qualification unless recovery < 10%.				
MATRIX SPIKE RECOVERY	1) % Recovery < CL but ≥ 10%	J	J-	UJ	Parent Sample
	2) % Recovery <10%	J	J-	R	
	3) % Recovery > CL	J	J+	no qual.	
	4) RPD > CL	J	J	UJ	

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
LABORATORY CONTROL SAMPLE RECOVERY	1) % Recovery < CL but ≥ 10%	J	J-	UJ	All samples in the same analytical batch (preparation batch)
	2) % Recovery <10%	J	J-	R	
	3) % Recovery > CL	J	J+	no qual.	
	4) RPD > CL	J	J	UJ	
REPORTING LIMITS	1) Reporting limits not matching the project specified limits	No qual.	No qual.	No qual.	Sample
	2) Results reported below the project reporting detection limit.	J	J	No qual.	
FIELD DUPLICATES	1) RPD > CL	No qual.	No qual.	no qual.	Non-compliant results

Table B-3

Data Qualifier Convention for GC/MS Analyses

Quality Control Item	Evaluation	Data Qualifier Flag			Sample(s) Qualified
		Detects			
		Non Biased	Biased	Nondetects	
FIELD BLANKS **EQUIPMENT BLANKS**	1) Common lab contaminants and tentatively identified compound (TIC) results within 10 times blank contamination	U	U	No qual.	All samples in the same sampling event
	2) Other lab contaminant results within 5 times blank contamination	U	U	No qual.	

Alternate qualifiers are acceptable on a case-by-case basis based upon validator professional judgment. All deviations f